information; so many travellers have lately recorded their impressions of Japan that it would now be hard for a writer to present any part of the subject from a wholly new point of view. Nevertheless, Mr. Dickson's book is one of exceptional interest, for, having already been in Japan, and having carefully studied its history, he knew exactly, on his return, the kind of phenomena which it would be best for him to study. Accordingly, we find in his narrative that he fastens attention chiefly on what is really characteristic of Japanese life, and that he understands how to connect particular facts with the general tendencies of Japanese society. Mr. Dickson was, of course, greatly struck by the enormous changes which had taken place from the time when he had formerly visited Japan, and he adds largely to the value of his observations by steadily comparing and contrasting the conditions which came under his notice four or five years ago with those he had noted twenty years before. About Japanese customs and institutions, so far as they are of native origin, he writes in a kindly and appreciative spirit; and he also finds something to admire in the effort of the educated classes "to advance in Western learning and the acquisition of scientific information." He declines, however, to commit himself to any very decided opinion as to the future of Japan. That she may have serious troubles in store for her he does not dispute; but, if they come, they will, he thinks, spring altogether from internal causes, and he has sufficient respect for her rulers to suggest that they "may have wisdom to avert a crash."

Statics for Beginners. By John Greaves, M.A. (London: Macmillan and Co., 1889.)

To simplify the subject of statics, and to make it attractive at the same time, is by no means an easy task, but the author of this little book has gone far towards succeeding in doing this. With the approval of several experienced teachers, the principle of the transmissibility of force has been discarded in favour of the ordinary method. The parallelogram of forces is deduced from the laws of motion, Duchayla's proof being given as an alternative. The definitions are admirable, and the various proofs are as simple as they well can be.

The examples are progressive and very numerous, typical ones being fully worked out.

The book is admirably adapted to serve as a stepping-stone to the larger treatises.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Structure and Distribution of Coral Reefs.

As I have had no personal experience of coral-reefs, I do not wish to touch more than the literary side of the controversy, but, in regard to this, Mr. Guppy's letter in the last number of NATURE (p. 53) obliges me to call attention to the fact that the "90-fathom reef" which he mentions is not at Socotra, but at Rodriguez. Also that, apart from Mr. Guppy, I found little evidence of "ignorance of the depths in which coral-reefs may form." On the contrary, there appeared to be a remarkable concurrence of testimony on the part of observers that, though occasionally a reef-building species may be found alive at depths greater than about 25 fathoms, this bathymetric limit for the growth of reefs, assigned by the earlier observers, is sufficiently accurate for all practical purposes.

It seems, then, to me that, with the evidence before us, the *onus probandi* of the supposition that a reef may commence at any depth which the exigencies of a particular case require, rests on Mr. Guppy (this done, no theory of coral-reef formation is needed—they may grow anywhere). But, till he can establish this hypothetical but fundamental proposition, Masámarhu Island is a fact for Darwin.

T. G. BONNEY.

The Turtle-headed Rock Cod.

A RARE specimen of the turtle-headed rock cod (*Glyptauchen panduratus*) has just come into the hands of Mr. J. Douglas Ogilby, of the Ichthyological Department of the Australian Museum at Sydney. This extraordinary fish belongs to the family of the red rock cods. Not many years ago these fishes (the red rock cod and its allies) formed a part of a most miscellaneous collection of species, which, under the general title of *Triglidæ*, included the true gurnards (*Trigla* and *Lepidotrigla*), the flying gurnards (*Dactylopterus*), and the flat-heads (*Platycephalus*). In 1860, however, Dr. Günther wisely separated these fishes from the *Triglidæ*, which family he broke up into four distinct groups. The first of these, named by him *Scorpænidæ*, is that to which the specimen just captured at Sydney belongs. All the *Scorpænidæ* are carnivorous marine fishes, most of which live at the bottom of the sea, and are generally provided with a powerful armature of the head and fin spines; while many possess skinny appendages on the head and body variously developed, which, owing to their resemblance to the fronds of seaweeds, serve the double purpose of enabling them the more easily to obtain their food, and the more effectually to conceal themselves from their enemies. As they are mostly of a small size, this latter point is evidently of no slight value, because, being slow, lazy fishes, they would, without some such means of protection, be unable to cope with their swifter antagonists. Nature has additionally protected this family by enabling it to vary its coloration according to any change of locality which it may be necessary to make, so as, chameleon-like, to fit itself for adaptation to the various phases of life under which it may be called on to exist. The genus *Glyptauchen*, of which the species just received by Mr. Ogilby is the sole representative, was separated in 1860 by Dr. A. Günther from the Cuvierian genus *Apistus*, for the reception of a fish from King George's Sound, Western Australia, described many years ago by Sir John Richardson under the name of *A. panduratus*. It has since been recorded from Port Jackson (Sydney), and the present specimen comes from Manly Beach, a few miles to the north of Port Jackson.

T.

Atmospheric Electricity.

YOUR correspondent, Mr. C. A. C. Bowlker, will, probably, be interested to learn that an electrical discharge, exactly similar to that which he recently experienced on the Glydyr Fawr (? "Elidyr") was described by the late Dr. Mann, and by Mr. F. G. Smith, in the Quarterly Journal of the Meteorological Society for October 1875.

Mr. Smith was engaged in August 1865 in ascending the Linguard Mountain from Pontresina, when his party was overtaken by bad weather. They reached the summit, however, and found, at one end of the ridge of which it consists, a flag-staff tipped with an iron point, and, at the other, a flat metal disk, serving to indicate bearings. Snow was falling, and nothing was visible except mist, but the "otherwise death-like stillness of the spot was broken by a strange, intermittent noise, resembling the rattling of hailstones against the panes of a window. A careful investigation of the cause of this noise soon made it apparent that it proceeded from the flag-staff, and was due to the passage of a continuous electrical discharge from the cloud in which the summit was wrapped."

After a time, the party, although, by Mr. Smith's own admission, "alarmed," held their alpenstocks, points upward, in the air, and, at once, each became conscious of an "electrical discharge passing through him, and causing a throbbing in the temples and a tingling in the finger-ends. The noise was still vigorously proceeding when, after three-quarters of an hour's stay, Mr. Smith and his party left the summit."

I called attention to a somewhat similar phenomenon ("An Engineer's Holiday," vol. i. p. 204), which I experienced on crossing the divide separating Central City from Idaho Springs, Colorado, the height of the ridge being 10,000 feet above sea-level.

There was thunder, and "it was raining, but without lightning, as we neared the divide, when I felt a tickling sensation on the backs of my hands. Presuming that a discharge was taking place between our bodies and the cloud, I tried to increase its intensity by holding my wet umbrella, point upwards, above the waggon. This, at once, produced distinct sensations in the hand and arm, the driver remarking, 'Oh! that's common enough here, though many don't know what it is,

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and others don't notice it.' This man was very nervous about crossing the divide at all while it was thundering, and plainly said if there was lightning he must wait for fair weather."

Possibly, sound might have accompanied this discharge, but the noise of our wheels would have drowned it.

Holmwood, Putney Hill, May 19. DAN. PIDGEON.

Rain-Clouds.

THE rain-cloud which Mr. Abercromby sketches in NATURE of May 2 (p. 12) is often seen in Upper Austria in summer. I have given a rough sketch of these thunder-clouds in the Austrian *Meteorological Journal*, vol. viii., 1873, p. 104.

Vienna, Hohe Warte 38. JULIUS HANN.

THE MUYBRIDGE PHOTOGRAPHS.[1]

MR. MUYBRIDGE is of English birth, a citizen of the Great Republic, and a professional photographer. Long before he applied his knowledge and skill to the subject of instantaneous photography of moving animals and human beings, he had obtained recognition by his work in producing valuable views of Californian scenery, of Panama and the West Indies. In 1872 he made the first lateral photograph of a horse trotting at full speed, for the purpose of settling a controversy among horsemen as to "whether all the feet of a horse while trotting were entirely clear of the ground" at at any one instant of time. It was not until 1877, however, that he conceived the idea that animal locomotion, which was then attracting considerable attention through the experiments of Prof. Marey, of the Collège de France, might be investigated by means of instantaneous photography, with results of value both to the artist and to the naturalist.

Marey's investigations were made by means of elastic cushions, or *tambours*, which were placed on the feet of the moving animal, and connected by flexible tubes to pencils writing on a chronograph. A record of the impact of each foot on the ground was thus obtained, and important information was deduced from these records as to the succession of footfalls and the time-intervals separating them in the various "gaits" of the horse.

Mr. Muybridge proposed to settle this and similar problems once for all by a complete and demonstrative graphic method. He arranged a number of cameras side by side, parallel to the track along which a horse was to be ridden. Each camera was provided with a specially contrived "exposer" (the word suggested by Mr. Muybridge in place of "shutter"), which could be let go by the pulling of a string. The strings connected with the "exposers" were placed across the path of the horse, so that they must be broken by him successively in his passage. At the instant of the breaking of the string, the exposer was brought into play in the corresponding camera, and thus the horse was photographed in a succession of intervals of about 14 inches, representing, according to the rate of progression of the horse, a time-interval of more or less than one-twentieth of a second.

In this way, in 1878, with the wet plates then in use a few sets of horses moving with various gaits were taken by Mr. Muybridge. The results were astonishing and conclusive. They were published at the expense of Mr. Leland Standford, under the title of "The Horse in Motion," and were exhibited in Europe in 1882 by Mr. Muybridge, together with other photographs taken in 1879. The reception which Mr. Muybridge met with on his visit to Paris and London was a great encouragement to him to proceed with his work. Meissonier, the great French painter, was enthusiastic in his admission of the value of the photographs as a guide to the observation required for all true artistic work, and the story goes that a particular attitude of the horse presented by him in one of his best known pictures which had been objected to by the critics as unnatural, was demonstrated by the Muybridge photographs to be perfectly correct. The series of little black *silhouettes*, which were at that time the form in which Mr. Muybridge obtained his pictures, were so contradictory of all preconceived notions as to what were the actual phases of attitude passed through by a trotting or a galloping horse, and so difficult to reconcile with the conventional representations of what is of course a totally different thing, viz. what we see when a trotting or galloping horse crosses our field of vision, that Mr. Muybridge determined on his return to America in 1883 to pursue the subject, and to apply improved methods of photography to the study of the rapid movements of a variety of animals and of man. The new dry plates now made it possible to obtain in exposures of 1/5000 of a second and less an amount of detail which was previously impossible. New automatic methods of registration and exposure were to be employed, larger pictures obtained, and the selected series printed without re-touching by a permanent photogravure process. The funds necessary to carry out this scheme were beyond Mr. Muybridge's own resources, and he for some time failed to obtain the necessary aid from any publisher or scientific institution. A Committee of the University of Pennsylvania thereupon came forward and placed £6000 at Mr. Muybridge's disposal, solely on condition that the first proceeds of the sale of the photographs when ready for publication should be assigned to the reimbursement of this sum. The words of Dr. William Pepper, the Provost of the University, in recording this most worthy action, are remarkable, and ably state that conception of the part of the University in the life of the State which we have so often advocated in these pages. "The function of a University," says Dr. Pepper, "is not limited to the mere instruction of students. Researches and original investigations, conducted by the mature scholars composing its Faculties, are an important part of its work; and in a larger conception of its duty should be included the aid which it can extend to investigators engaged in researches too costly or elaborate to be accomplished by private means. When ample provision is made in these several directions, we shall have the University adequately equipped and prepared to exert fully her great function as a discoverer and teacher of truth."

As a result of the action of the University of Pennsylvania in providing Mr. Muybridge with the means to carry out his experiments, we have a really marvellous set of plates—781 in number—each containing a series of from twelve to thirty pictures representing successive instantaneous phases of movement. About 500 of the plates represent men, women, and children, nude and semi-nude, in successive phases of walking, running, jumping, dancing, bathing, fencing, wrestling, boxing, and other such exercises. The rest of the plates give similar studies of the various gaits of horses, asses, mules, oxen, deer, elephants, camels, raccoons, apes, sloths, and other quadrupeds, as well as of the flight of birds. Many of these photographs have been, this spring, exhibited in London by Mr. Muybridge, projected on the screen by electric light—at the Royal Society, the Royal Institution, the Royal Academy, and the South Kensington Art School. The whole series can now be obtained by those who desire to possess them, and to assist the University of of Pennsylvania by bearing a portion of the expense of their production. Series of not less than one hundred plates are also to be disposed of, and may be seen on application to Mr. Muybridge, who is at present in London.

The interest which these photographs present from the scientific point of view is threefold:—

(A) They, first of all, are important as examples of a very nearly perfect method of investigation by photographic and electrical appliances.

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[1] "Animal Locomotion: an Electro-photographic Investigation of Consecutive Phases of Animal Movements." By Eadweard Muybridge. (Published under the auspices of the University of Pennsylvania, 1888.)

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